SAS: Today’s Fast and Flexible Storage Fabric

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Abstract

SAS is the backbone of nearly every enterprise storage deployment, rapidly evolving, adding new features and enhanced capabilities, and offering “no compromise” system performance. SAS not only excels as a device level interface, its versatility, reliability and scalability have made it the connectivity standard of choice for creating new enterprise storage architectures.

This presentation covers the advantages of using SAS as a device interface and how its capabilities as a connectivity solution are changing the way data centers are being deployed. 12Gb/s SAS transfer rates, bandwidth aggregation, SAS fabrics (including switches) active connections, and multi-function connectors allow data center architects to create sustainable storage solutions that scale well into next-generation 24Gb/s SAS designs and beyond.
Today’s Takeaways

❖ Flexibility of SAS is Unparalleled
  ❖ Media flexibility
  ❖ Scalability
  ❖ System architectures

❖ SAS Technology Addresses a Very Large, Growing Market

❖ SAS Continues to Evolve through Innovation
  ❖ Performance
  ❖ Features
SAS – Preserving the Past, Creating the Future

Preserve Legacy SCSI
• 25 years of SCSI middleware

Customer Choice
• 3.5” and 2.5” form factors
• Plug compatible
• Multi-protocol

Future Architected
• Protocol extends to new technologies
• Serial, switchable
• SFF connectors

Usability
• Dual-ported
• Point-to-point
• Cost equal to SCSI

Performance
• Wide ports
  • Interconnect
  • MultiLink SAS™
• Low overhead

Scalable
• 1000s of connections

SAS: Today’s Fast and Flexible Storage Fabric
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SAS & SATA Span the Storage Spectrum

- Controllers/ROCs/HBAs
- Expanders
- SAS/SATA HDDs
- SAS/SATA SSDs

- SAS Fabrics
- Expanders
- SAS switches
- Bridges
- Port multiplexers

- External Storage
- Controllers/ROCs/HBAs
- Expanders
- SAS/SATA HDDs
- SAS/SATA SSDs
- SAS/SATA tape

- Media
- SAS HDDs
- SAS SSDs
- SATA HDDs
- SATA SSDs
- Near-line SAS HDDs
- SMR HDDs

SAS is the Predominant Enterprise Drive Interface
Scalability in Server & Hyper-Converged Architectures

Simple DAS
- High Performance
- Inexpensive
- Modular

Extended DAS
- Pay-as-you-grow
- High Capacity
Scalability in External Storage Architectures

External Storage:
- Native High-Availability
- Modular
- Simplified, Robust Cabling
- Scales to 1000s of Devices
Enterprise Unit Shipments

95% of All Enterprise Shipments in 2019 Require SAS Infrastructure

Source: TRENDFOCUS, Jan 2016
## Bandwidth by the Numbers

<table>
<thead>
<tr>
<th>No. of Links / Lanes</th>
<th>SATA</th>
<th>x1 PCIe</th>
<th>x1 SAS</th>
<th>x2 PCIe</th>
<th>x2 SAS MultiLink SAS™</th>
<th>x4 PCIe</th>
<th>x4 SAS MultiLink SAS™</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

### Transfer Rate per Link/Lane

<table>
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<tr>
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</thead>
<tbody>
<tr>
<td>Max Bandwidth</td>
<td>0.6 GB/s</td>
<td>2.0 GB/s</td>
<td>2.4 GB/s</td>
<td>4.0 GB/s</td>
<td>4.8 GB/s</td>
<td>8.0 GB/s</td>
<td>9.6 GB/s</td>
</tr>
</tbody>
</table>

SAS Supplies 20% More bandwidth Per Lane
Read Latencies Dominated by NAND Latencies (and will continue to increase)
SAS Technology Roadmap

First Plugfest (leading edge)

First End-User Products (approximately 12–18 months later)


3Gb/s SAS

6Gb/s SAS

12Gb/s SAS

24Gb/s SAS

Source: SCSI Trade Association – Aug 2015
Recent Innovations in SAS

- Storage Intelligence
- Persistent Connections
- Enhanced Power Control
- Shingled Magnetic Recording Support

Recent SAS Innovations - the Focus of the May SAS Plugfest
Storage Intelligence

Streams
- Provides hints to SSD about data sets that have similar expected lifetimes
- Reduces intermixing of data from different applications, thus reducing fragmentation during garbage collection
- Improves performance
- Reduces write amplification and improves endurance

Background Activity Control
- Provides hints to SSD to optimize timing of background activities (e.g., garbage collection)
- Provides more consistent performance during peak activity times
Why Shingled Magnetic Recording?

Areal Density Accelerator

- Much higher track density
- Overall AD growth 25%/Y vs. 15%/Y
- 65% greater maximum capacity by 2020

Capacity Growth
(3.5" Capacity Enterprise)

HDD Capacity (TB)


With SMR

Without SMR
The Need for Speed

Estimated 50B Connected Devices in 2020

DoD Drones Capable of Capturing 430 PB/Day

Global Forecast of Data Generated Daily by Surveillance Cameras Shipped in a Year (in Petabytes)

Surveillance Cameras Capture 859 PB/Day in 2017
24Gb/s SAS Objectives

- Double the Effective Bandwidth of 12Gb/s SAS
- Backwards Compatibility
  - Support for two generations of backward compatibility
  - Leverage existing ecosystem (tools, test equipment)
- Preserve the Existing SAS Value Proposition
  - **Reliability** – Robust error handling
  - **Scalability** – Scalable to 1,000s of devices
  - **Flexibility** – SAS infrastructure supports SAS and SATA devices
  - **Serviceability** – Surprise add/remove media and cables
  - **Manageability** – Storage management built into the standard
- Align with a 2019 Platform Launch
Summary

- Logical SCSI Lives Across the Storage Spectrum
- Proven Enterprise Attributes and Growing Footprint
- Flexible Architecture = Platform for Innovation
  - Enterprise reliability, improved connectivity
  - Low-latency device performance, capacity scaling
- A Multi-generational Investment
  - Enterprise-hardened middleware
  - Preserves backward compatibility
  - Roadmaps preserve legacy investments
The SNIA Education Committee thanks the following Individuals for their contributions to this Tutorial.

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